

# Eutrophication potential of foods and comparison to carbon footprints

Xiaobo Xue, Graduate Student

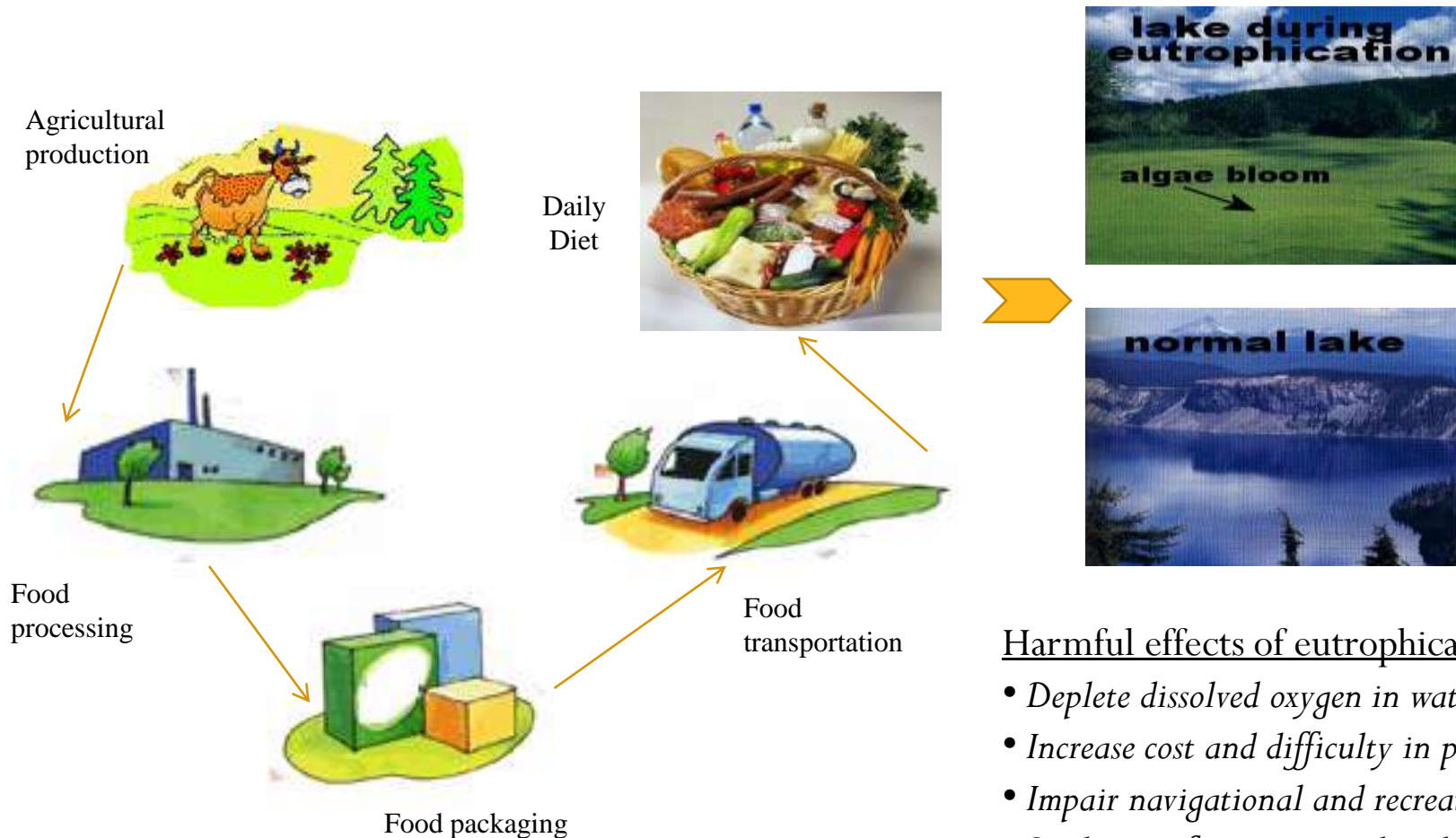
Amy E. Landis, Assistant Professor

Department of Civil & Environmental Engineering

University of Pittsburgh

**Food supply chains** have social, economic and environmental impacts.

**Eutrophication** and **hypoxic** issues, result from agricultural and associated activities, cause water quality degradation.



**Harmful effects of eutrophication:**

- *Deplete dissolved oxygen in waters*
- *Increase cost and difficulty in purifying water*
- *Impair navigational and recreational use*
- *Produce surface scums and undesirable odors*
- *Loss of biodiversity*

# Functional units

- g nitrogen/kg food

*normalized units:*

- g nitrogen/ \$ food
- g nitrogen/ Kcal energy of food

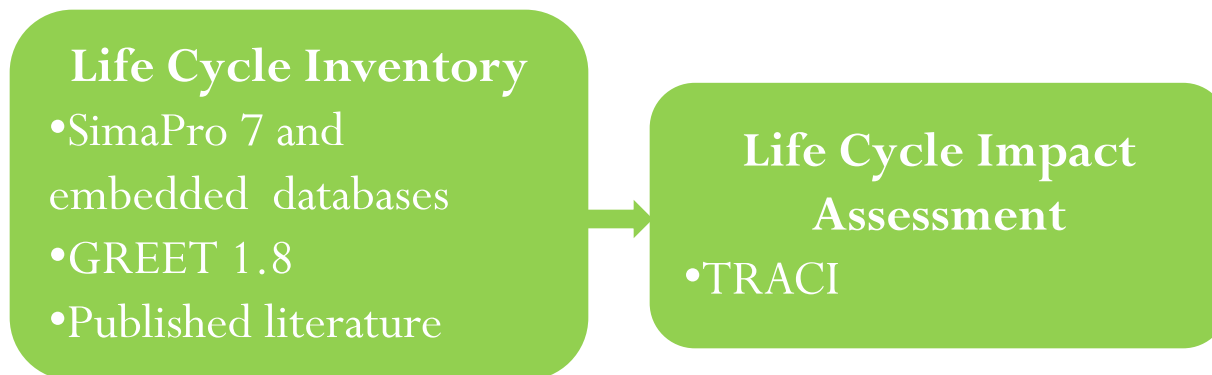
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# LCA Methods

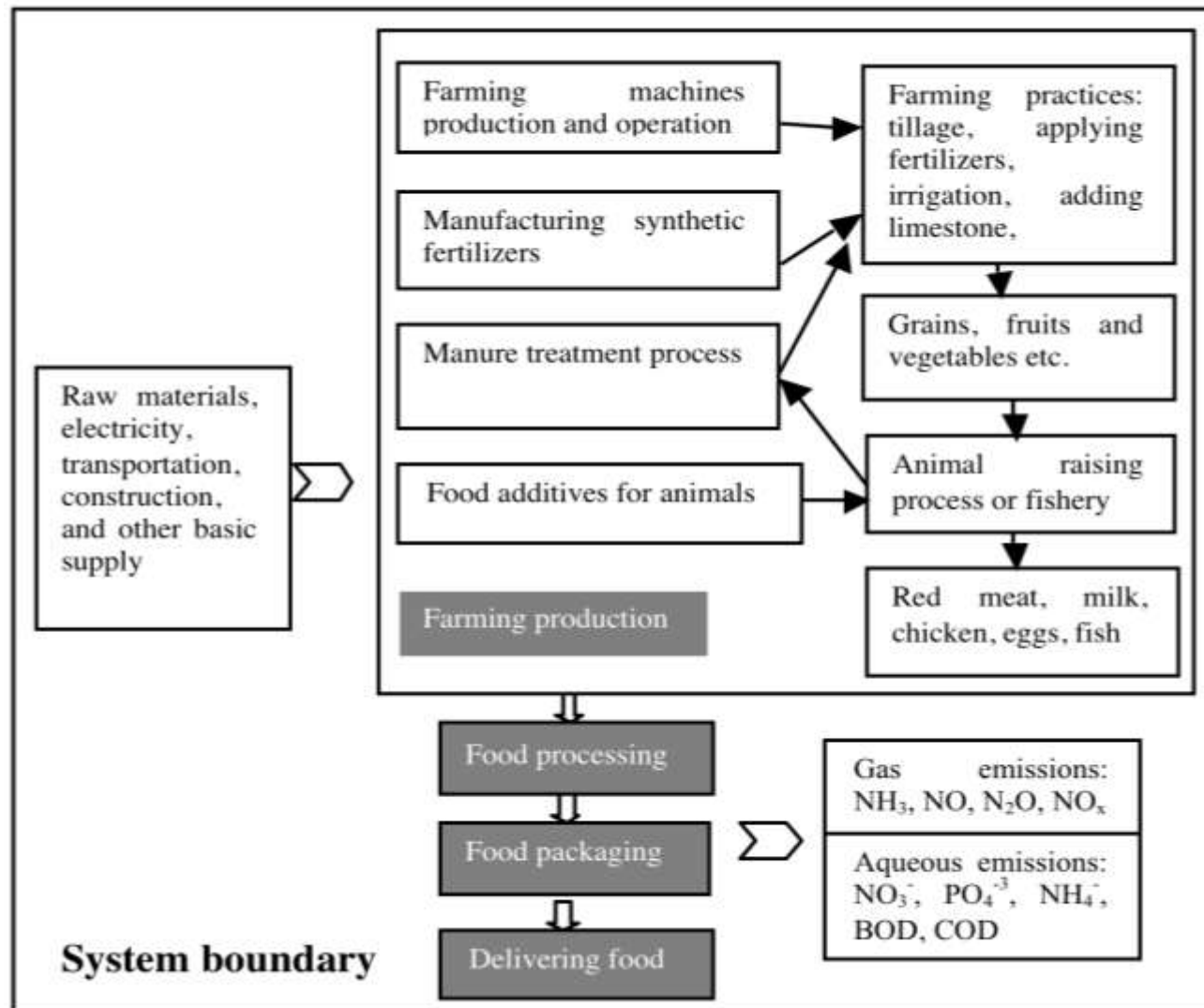


\*MCA (Monte Carlo Analysis) is used to quantify variability and uncertainty of life cycle inventory.

# LCI Data Sources

Stages	Farming	Food processing	Food packaging	Transportation
<b>Emissions of concern</b>	NH <sub>3</sub> ,NO,N <sub>2</sub> O, NO <sub>x</sub> ,NO <sub>3</sub> <sup>-</sup> ,PO <sub>4</sub> <sup>-3</sup> , NH <sub>4</sub> <sup>-</sup> ,BOD, COD	NH <sub>3</sub> , NO, N <sub>2</sub> O, NO <sub>x</sub> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>-3</sup> , NH <sub>4</sub> <sup>-</sup> , BOD, COD	NH <sub>3</sub> , NO, N <sub>2</sub> O, NO <sub>x</sub> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>-3</sup> , NH <sub>4</sub> <sup>-</sup> , BOD, COD	NO, N <sub>2</sub> O, NO <sub>x</sub>
<b>Database</b>	<ul style="list-style-type: none"> <li>•Peer reviewed articles</li> <li>•ecoinvent v2</li> <li>•LCA food DK</li> <li>•Industry data 2.0</li> <li>•BUWAL250</li> <li>•IDEMAT 2001</li> </ul>	<ul style="list-style-type: none"> <li>•Peer reviewed articles</li> <li>•ecoinvent v2</li> <li>•LCA food DK</li> <li>•Industry data 2.0</li> <li>•BUWAL250</li> <li>•IDEMAT 2001</li> </ul>	<ul style="list-style-type: none"> <li>•Ecoinvent v2</li> <li>•LCA food DK</li> <li>•Industry data 2.0</li> <li>•BUWAL250</li> <li>•IDEMAT 2001</li> </ul>	<ul style="list-style-type: none"> <li>•GREET 1.8</li> </ul>

# System Boundary



# LCA Model Assumptions

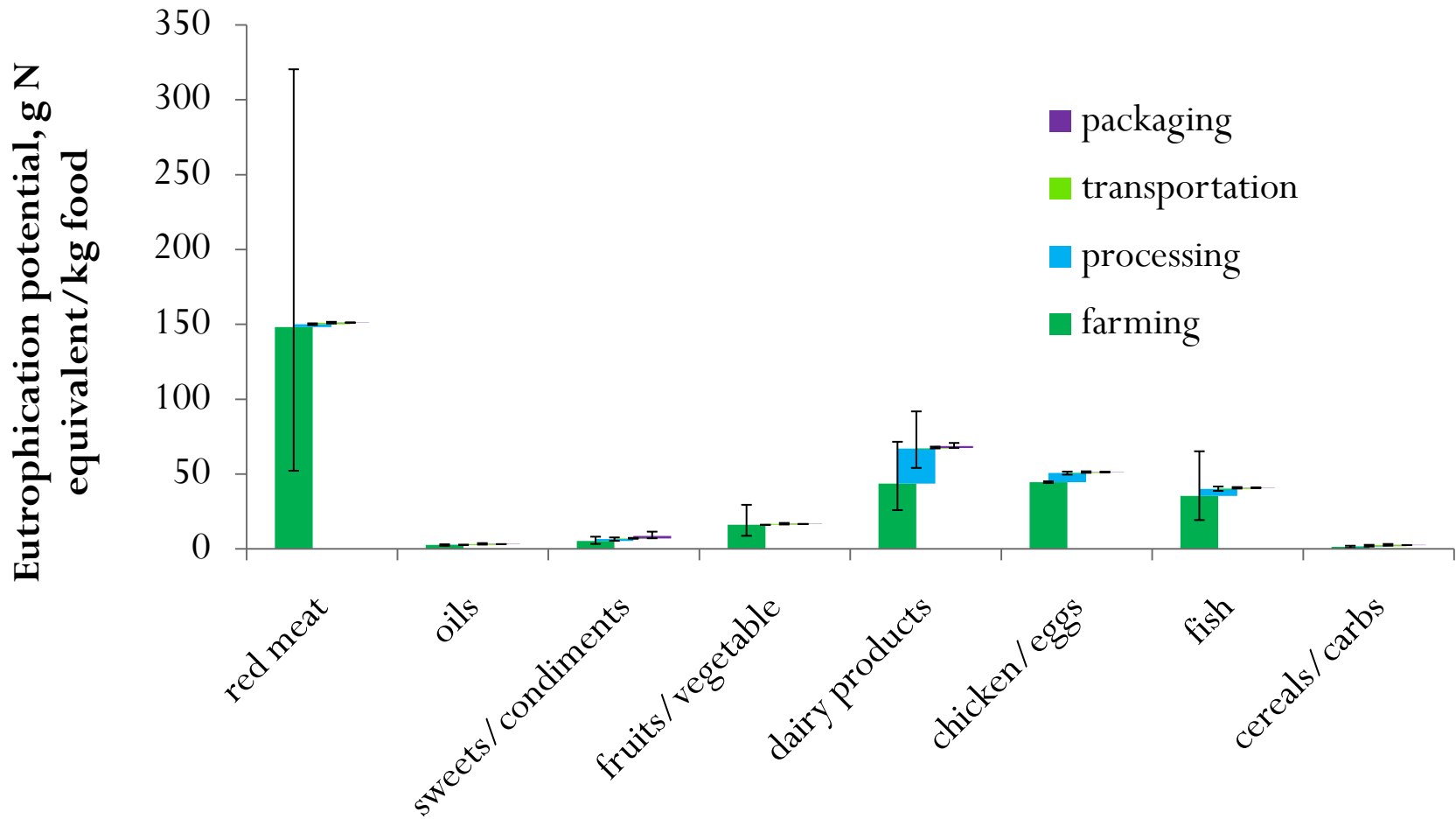
## **Related to Transportation:**

- All GREET default assumptions are followed to calculate gas emissions during transportation stage .
- Distances and transportation modes for delivering food subgroups are obtained from publications.

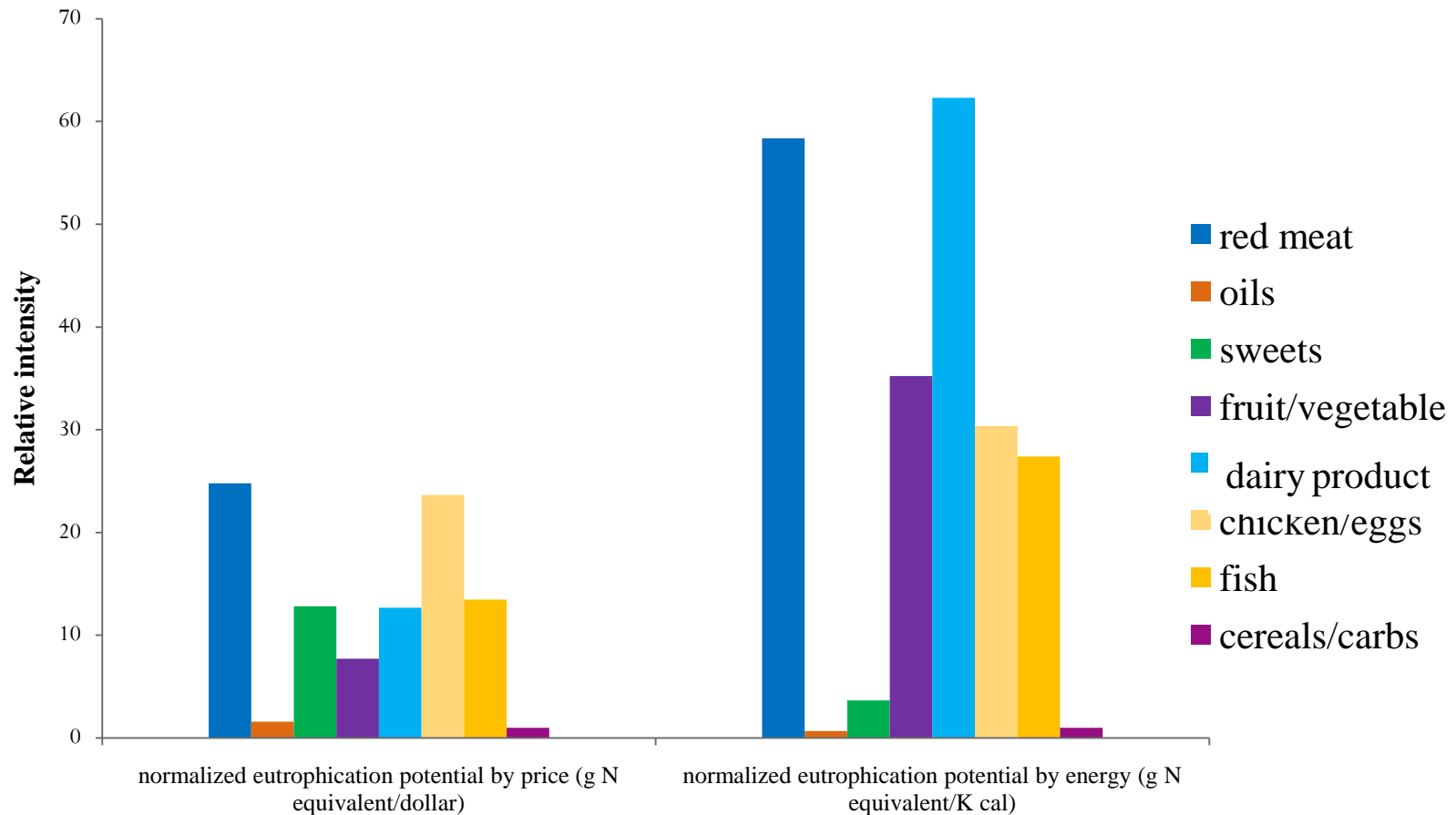
## **Related to Packaging**

- Only considered commercial packaging, not transportation containers

# Eutrophication Potential of Food Groups

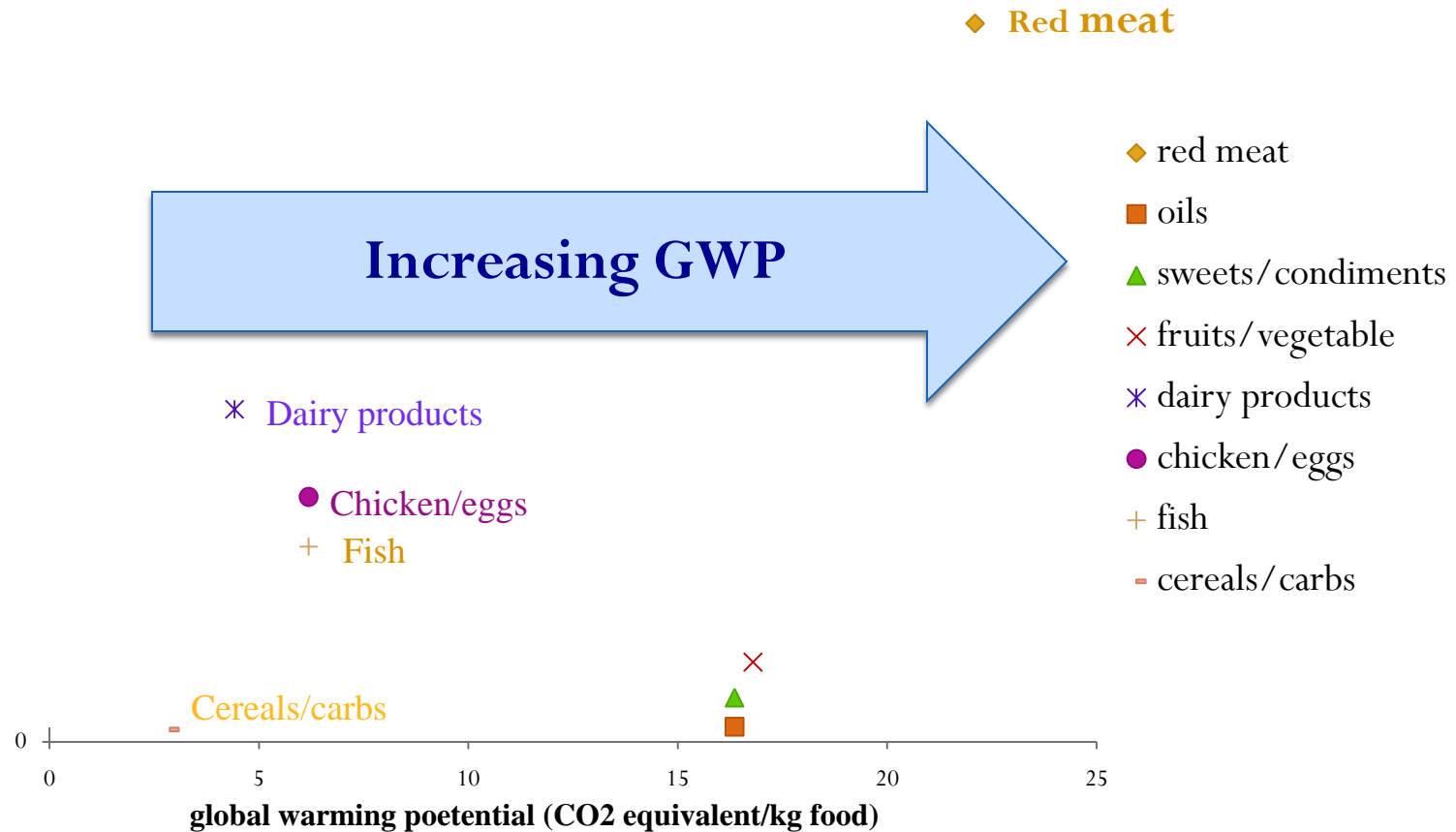


# Eutrophication Potential (with price, energy functional unit)



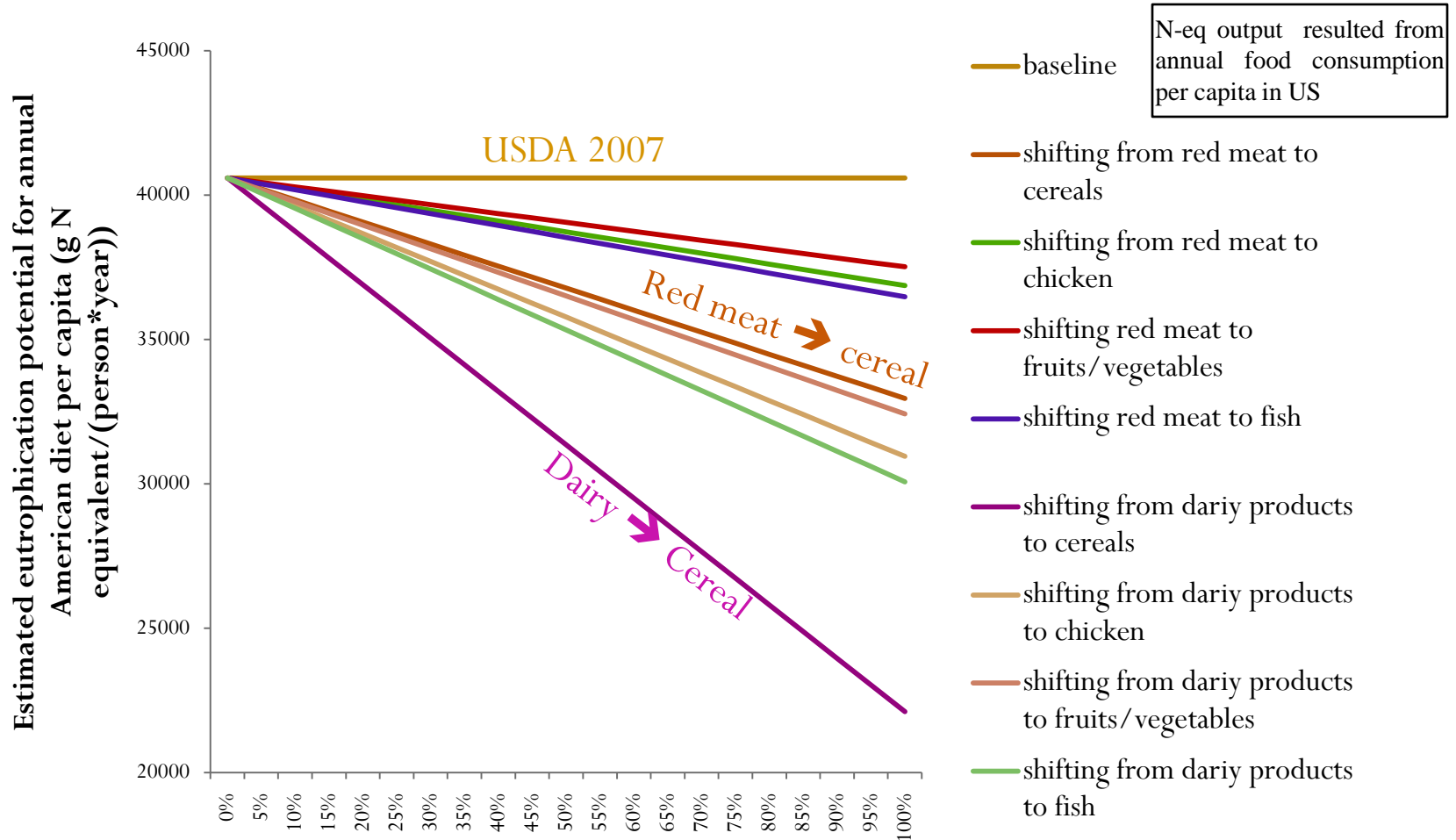
Comparison of normalization factors for eutrophication potential of foods.

# Comparison of C-footprint and N-footprint



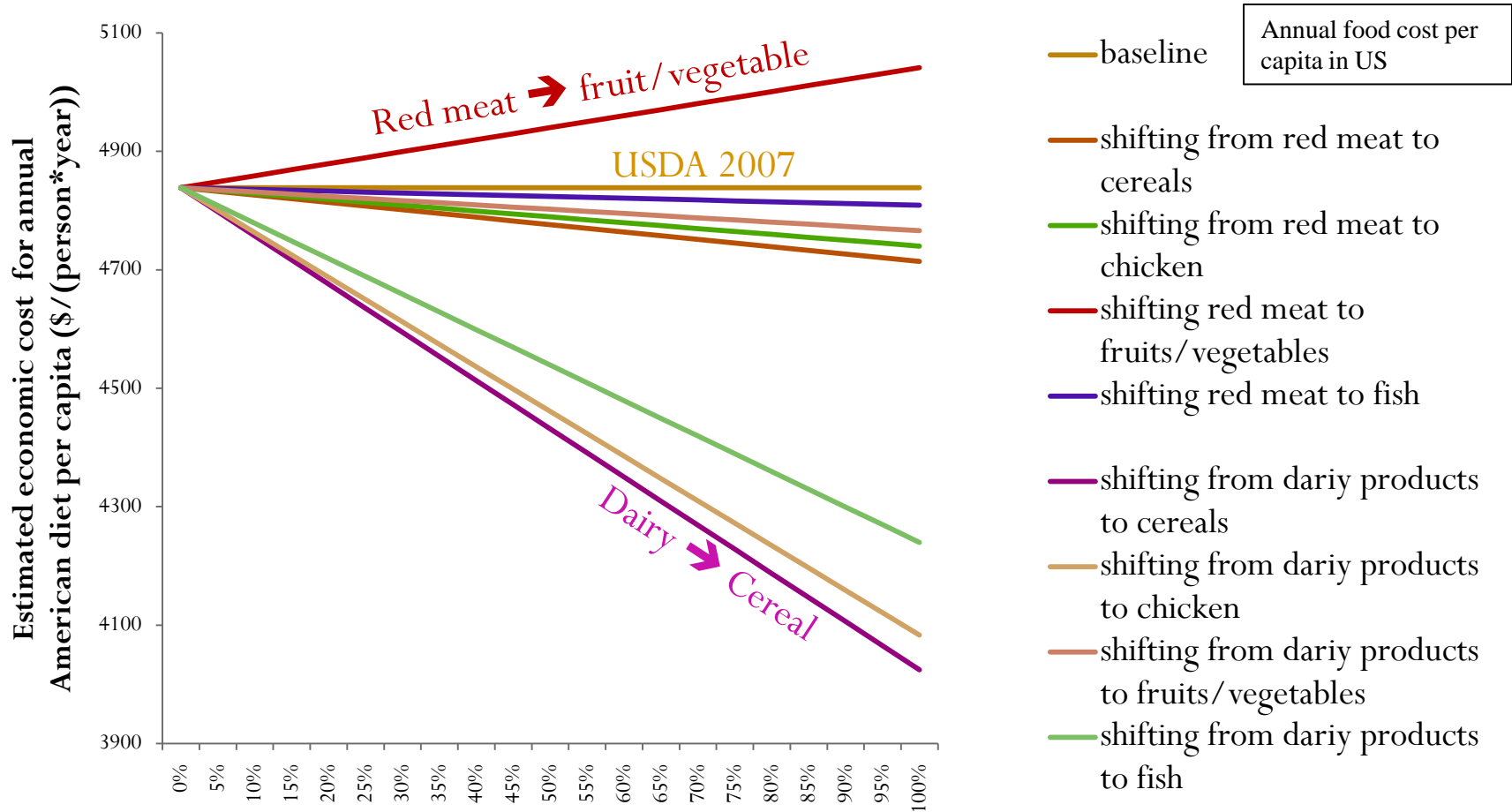
Comparison of carbon footprints and nitrogen equivalent footprints. Carbon footprints values are obtained from: Weber et al, *Environ. Sci. Technol.* **2008**.42, 3508-3513

# Shifting Food Consumption Patterns



Eutrophication potential reductions due to consumption shifts from high nitrogen profile foods to low nitrogen profile foods, when the same energy is maintained

# Costs of Shifting Food Consumption Patterns



Cost reductions due to consumption shifts from high nitrogen profile foods to low nitrogen profile foods, when the same energy is maintained.

# Conclusions

- Red meat has high eutrophication potential *and* C-footprint
- Cereal products have low eutrophication potential *and* C-footprint
- Adding N-impact changes the 'ranking' for Dairy Products, chicken, eggs
- Shifting Food Consumption can result in higher costs, but can be very effective in reducing eutrophication potential

# Acknowledgments

- Drs. Melissa Bilec & Joe Marriott
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- LCA IX Conference Organizers

# Thank You!

Contact: Xiaobo Xue

[xix17@pitt.edu](mailto:xix17@pitt.edu)